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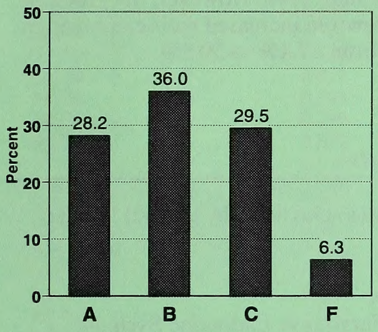
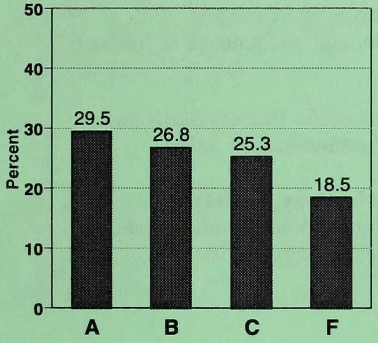
Biology 30

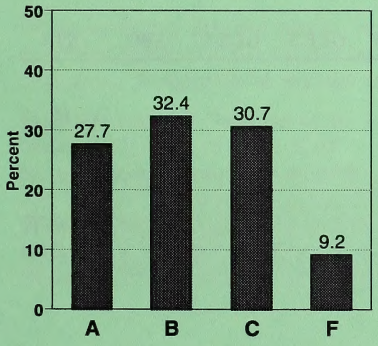
Diploma Examination Results
Examiners' Report for June 1998



School-Awarded Mark



Diploma Examination Mark



Final Course Mark

The summary information in this report provides teachers, school administrators, and students with an overview of results from the June 1998 administration of the Biology 30 Diploma Examination. This information is most helpful when used in conjunction with the detailed school and jurisdiction reports that have been provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined January, April, June, and August results is made available annually.

Description of the Examination

The Biology 30 Diploma Examination consists of 48 multiple-choice questions worth 60%, eight numerical-response questions worth 10%, and two written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 8 813 students in Alberta who wrote the June 1998 examination. This represents a decrease of 209 students compared with June 1997 and a decrease of 772 students compared with June 1996. (The total number of students writing in the year has remained stable. The April examination sitting has decreased the number of students writing both January and June examinations over these three years.)

- 90.8% of the 8 813 students achieved the acceptable standard (a final course mark of 50% or higher).
- 27.7% of the 8 813 students achieved the standard of excellence (a final course mark of 80% or higher).

Generally, student achievement in Biology 30 was good. The percentage of students who achieved the acceptable standard (90.8%) was nearly identical to the percentage for June 1997 (90.6%). Most students demonstrated a very good understanding of human reproductive, endocrine, and nervous systems. They demonstrated a good understanding of concepts related to the interaction of populations. Some students had difficulty with concepts related to cell division, molecular genetics, and population genetics, and to the links between these concepts. The majority of students were able to demonstrate a very good understanding of science, technology, and society connections.

Approximately 61.0% of the students who took the course were female. Of these female students, approximately 91.5% achieved the acceptable standard on the course, compared with 89.9% of the male students. The standard of excellence was achieved by approximately 28% of these female students, compared with 27% of the male population.

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Provincial Averages

- The average school-awarded mark was 69.6%.
- The average diploma examination mark was 67.2%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 68.7%.

Approximately 6.3% of the students who wrote the examination in June 1998 and received a school-awarded mark had written at least one other Biology 30 Diploma Examination during the January 1996 to June 1998 period. This subpopulation (563) achieved an examination average of 59.5%, compared with 67.8% for the population (8 250) who first wrote the Biology 30 examination in June 1998. However, the group of students who rewrote increased their examination average score from 47.4% to 59.5%.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It is designed so that students achieving the acceptable standard will obtain a mark of 50% or higher, and students achieving the standard of excellence will obtain a mark of 80% or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer. For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, the "Difficulty" is the mean score (out of 1) achieved by students who wrote the examination.

Questions are also classified by general learner expectations.

Knowledge:

GLE 1	Nervous & Endocrine Systems
GLE 2	Reproductive Systems & Hormones
GLE 3	Differentiation & Development
GLE 4	Cell Division & Mendelian Genetics
GLE 5	Molecular Genetics
GLE 6	Population Genetics & Interaction

Skills:

SPC	Scientific Process Skills and Communication Skills

Science, Technology, Society:

STS	Connections Among Science, Technology, & Society

Blueprint

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPC	STS
MC1	A	0.661	✓							
MC2	A	0.871	✓							
MC3	D	0.696	✓							✓
MC4	A	0.746	✓							
MC5	C	0.664	✓							
NR1	5462	0.353	✓							
MC6	C	0.786	✓							
MC7	D	0.671	✓							✓
MC8	C	0.585	✓							
MC9	A	0.819	✓							
MC10	B	0.646	✓							
MC11	A	0.740	✓							
MC12	D	0.821	✓							
MC13	A	0.646	✓							
MC14	C	0.650	✓							✓
MC15	D	0.764	✓							✓
MC16	D	0.757		✓						
MC17	B	0.676				✓				

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPC	STS
MC18	C	0.606		✓						
MC19	D	0.377		✓						
NR2	46	0.762		✓						
MC20	D	0.731			✓					✓
MC21	C	0.749			✓					
MC22	C	0.753			✓					
NR3	4213	0.669			✓					
MC23	C	0.699				✓				
MC24	D	0.699				✓				
NR4	1246	0.391				✓				
MC25	D	0.677				✓				
MC26	D	0.544				✓				✓
MC27	D	0.779				✓			✓	✓
MC28	C	0.632				✓			✓	
MC29	B	0.839				✓				✓
MC30	A	0.722				✓				✓
MC31	C	0.858				✓				✓
NR5	12.5	0.666				✓			✓	✓
MC32	A	0.879				✓			✓	✓
MC33	B	0.569				✓			✓	
MC34	C	0.641	✓						✓	
MC35	D	0.772				✓			✓	✓
MC36	A	0.718				✓				✓
NR6	1342	0.572				✓			✓	
NR7	18	0.432						✓	✓	
MC37	A	0.755					✓			
MC38	B	0.827					✓		✓	
MC39	B	0.836					✓			
MC40	B	0.725					✓		✓	
MC41	A	0.600					✓			
MC42	D	0.635					✓			
MC43	D	0.484					✓			
MC44	B	0.563					✓			
MC45	B	0.666				✓				
NR8	2314	0.800					✓			
MC46	C	0.909						✓		
MC47	A	0.902						✓		
MC48	A	0.599						✓		
WR1	—	0.597						✓(12)	✓(12)	✓(5)
WR2	—	0.637		✓	✓	✓			✓	✓

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 38.6 out of 56
Multiple choice: 34.0 out of 48
Numerical response: 4.6 out of 8

Written Response: 15.0 out of 24
Question 1: 7.2 out of 12
Question 2: 2.6 out of 4 (weighted)

Raw Score Averages for Machine-Scored Items and Written-Response Question 1 by General Learner Expectations

General Learner Expectations:

GLE 1	Nervous & Endocrine Systems	11.8	out of	17
GLE 2	Reproductive Systems & Hormones	2.5	out of	4
GLE 3	Differentiation & Development	2.9	out of	4
GLE 4	Cell Division & Mendelian Genetics	12.4	out of	18
GLE 5	Molecular Genetics	6.2	out of	9
GLE 6	Population Genetics & Interaction	10.0	out of	16
SPC	Scientific Process and Communication Skills	14.7	out of	23
STS	Connections in Science, Technology, and Society	13.5	out of	19

Multiple-Choice and Numerical-Response Questions

The following table gives results for seven questions selected from the examination. The table shows the percentage of students in four groups that answered the question correctly. The comments following the table discuss some of the understandings and skills the students may have used to answer these questions.

Percentage of Students Correctly Answering Selected Machine-Scored Questions

	Question Number						
Student Group	**NR1**	**NR4**	**MC26**	**MC28**	**NR6**	**NR7**	**MC41**
All Students	35.3	39.1	54.4	63.2	57.2	43.2	60.0
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	69.4	72.1	76.4	93.1	89.9	80.6	84.5
Students achieving the *acceptable standard* (between 50% and 79%, B or C) on the whole examination	26.3	31.8	49.6	60.9	53.0	34.7	55.2
Students who have not achieved the *acceptable standard* (49% or less, or F) on the whole examination	6.2	7.2	32.5	21.8	16.0	7.4	34.2

Use the following information to answer the next question.

> Bats emit a high-frequency "chirp" as they fly. They listen for the reflection of this sound off of moths, their food. By interpreting the time it takes for the sound to return, they can effectively catch moths, even in total darkness.
>
> —from *Curtis, 1983*

Numerical Response

1. Assume that the ear structure of bats is similar to that of humans. What pathway would these "chirp" sound waves take through the ear to be detected by the temporal lobe?

Structures of the Ear

1 Semicircular canals
2 Organ of Corti
3 Eustachian tube
4 Tympanic membrane
5 Auditory canal
6 Ossicles

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: 5462

Numerical-response question 1 required students to sequence the pathway that sound waves travel through the ear to reach the brain to be interpreted. In general, most students had difficulty identifying the structures of the ear that were part of this pathway. The most common errors were that students included the semicircular canals, which are involved in detecting sensations of equilibrium, and the Eustachian tube, which equalizes pressure between the middle and outer ears.

Use the following information to answer the next question.

> **Some Events That Occur During Cell Division**
>
> **1** Centromeres divide
> **2** Cytokinesis occurs
> **3** Identical cells are produced
> **4** DNA is replicated
> **5** Haploid cells are produced
> **6** Spindle fibres form

Numerical Response

4. Four events that occur in **both** human asexual and sexual cell reproduction are represented by numbers ___________.

(Record your **four-digit answer in lowest-to-highest numerical order** in the numerical-response section of the answer sheet.)

Answer: 1246

Numerical-response question 4 required students to identify events that occur in both mitosis and meiosis in humans. In general, most students had difficulty eliminating the two events that did not occur in both processes. The most common error was that students included "Identical cells are produced" in the sequence. This indicates that these students do not recognize that homologous pair separation in meiosis I results in non-identical cells being produced by this process.

Use the following information to answer the next question.

During his study of genetics, Gregory Mendel cross-pollinated many pea plants. He recorded the number and types of offspring produced and applied his knowledge of mathematics to create explanations for his observations. He hypothesized that factors are inherited separately and proposed the law of segregation.

26. The modern-day interpretation of Mendel's law of segregation is that

A. alleles are expressed independently during mitosis
B. alleles are expressed independently during meiosis
C. paired alleles separate during mitosis and are distributed into different gametes
***D.** paired alleles separate during meiosis and are distributed into different gametes

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Use the following information to answer the next question.

In cattle, hornless or polled (P) is dominant over the horned (p) condition. This is an autosomal trait. The semen of a polled bull is used to artificially inseminate three cows. Cow 1 (horned) produces a horned calf, cow 2 (polled) produces a horned calf, and cow 3 (polled) produces a polled calf.

28. Which of the above cattle could have two possible genotypes?

A. Cow 1
B. Cow 2
***C.** Cow 3
D. The polled bull

Use the following information to answer the next question.

In *Drosphila* (fruit flies), the genes for pink eyes, rough eyes, curled wings, and hairless bristles are located on chromosome 3.

Genes	Crossover Frequency
• pink eyes and hairless bristles	21.5
• hairless bristles and curled wings	19.5
• rough eyes and curled wings	41.1
• pink eyes and rough eyes	43.1
• rough eyes and hairless bristles	21.6

Legend

Pink eyes – 1
Rough eyes –2
Curled wings – 3
Hairless bristles – 4

—from *Griffiths*, 1993

Numerical Response

6. Use the legend to indicate the order of these genes along a chromosome.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: 1342

Multiple-choice question 26 required students to apply Mendel's law of segregation to modern–day knowledge of the process of meiosis and its relationship to genetic inheritance. In general, most students were able to identify that segregation occurred during meiosis. The most common error was that students incorrectly identified the description of the process of segregation. This indicates that these students do not recognize the links between separation of homologous pairs of chromosomes and their alleles, the production of non-identical gametes, and the inheritance of genetic traits.

Multiple-choice question 28 required students to determine the possible genotypes of three cows and a bull and then select the animal that could have two possible genotypes. Students achieving at the standard of excellence were readily able to identify Cow 3 as the animal with two possible genotypes (Pp or PP); however, most of the other students had some degree of difficulty. The most common error was that students chose Cow 2, which only has one possible genotype (Pp). This indicates that these students do not recognize that an individual that does not have a recessive traits must be a carrier of that trait's allele in order to pass the trait on to their offspring.

Numerical-response question 6 required students to create a gene map from crossover frequencies for four *Drosophila* genes in order to determine the order of those genes. Students achieving at the standard of excellence were readily able to create an accurate gene map in order to sequence these genes from the data provided; however, most other students had some degree of difficulty. The most common error was that students placed pink eyes and rough eyes closest together in the sequence instead of farthest apart. This indicates that these students do not understand that the higher the crossover frequency, the farther apart two genes must be. Genes that are closest to each other on a chromosome are most likely to stay together.

Numerical Response

7. In a large population of randomly breeding *Drosphila*, 1% of the population exhibits burgundy eye colour, an autosomal recessive trait. According to the Hardy–Weinberg equilibrium, what **percentage** of the population is expected to be heterozygous?

(Record your **answer as a whole number percentage** in the numerical-response section of the answer sheet.)

Answer: 18%

Use the following information to answer the next question.

> The polymerase chain reaction technique (PCR) makes it possible to produce a large number of copies of a specific DNA sequence in a relatively short time. When heated to 94°C, double-stranded DNA molecules separate completely, forming two single strands. Later, after the temperature is lowered and with DNA polymerase present, complementary DNA strands form. The process of heating and cooking can be repeated to produce as many copies of the DNA as is required.
>
> —from *Klug and Cummings, 1997*

41. PCR is similar to a process that normally occurs in cells prior to cell division. The row that identifies the site and name of this process is

Row	Site	Process
*A.	nucleus	replication
B.	nucleus	transcription
C.	cytoplasm	replication
D.	cytoplasm	transcription

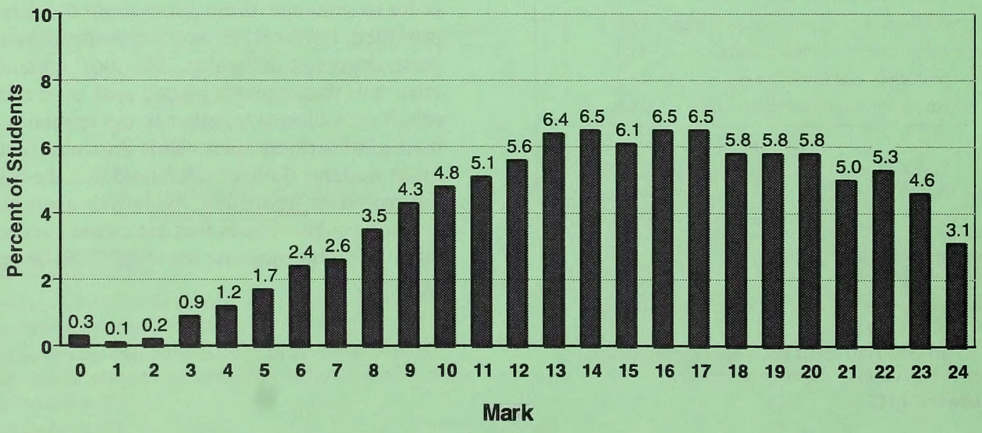
Numerical-response question 7 required students to apply Hardy–Weinburg formulas to calculate the percentage of *Drosophila* flies that are heterozygous for a recessive trait in a population, when given the percentage of homozygotes for the recessive trait. Students achieving at the standard of excellence were readily able to do these calculations; however, most other students had some degree of difficulty. The most common error was that students calculated the percentage as 50%. This indicates that these student used Punnet squares to determine the probability of two heterozygotes producing heterozygous offspring and did not recognize this as a population genetics question.

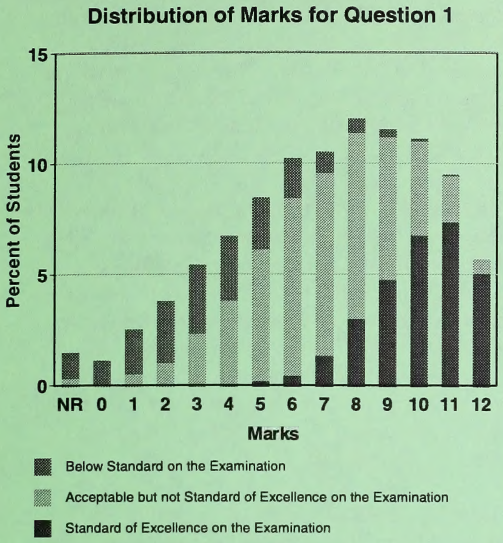
Multiple-choice question 41 required students to identify the process of replication of DNA as similar to PCR, and to identify where DNA replication occurs in cells. Students achieving at the standard of excellence were readily able to identify the process and where it occurs in cells; however, most of other students had some degree of difficulty. The most common error for these students was that they selected transcription as the process. This indicates that these students do not know the meaning of the terms used to describe the processes of DNA replication and the steps in protein synthesis.

Written-Response Questions

Of the students who wrote the examination, 0.3% received no marks for both written-response questions, 73.0% received 12 marks or more out of 24, and 23.8% received 20 marks or more out of 24.

Distribution of Marks for Written Response





Question 1 Almost all students (98.4%) who wrote the examination received some marks on this process skill question related to a study on the impact of human activity on grizzly bears in the Bow River Watershed. The population density of grizzly bears in an area, their biotic potential, the effects of habitat fragmentation on genetic diversity and survival of grizzlies, and the effects of overcrowding on reproductive rates for female grizzlies are aspects of the grizzly bears' ecology presented in this question.

The mean of part a was approximately 71%, which indicates that students were able to calculate the population density of grizzly bears in a given area (Banff National Park). Students who had difficulty with this question often failed to provide units or to accurately calculate the density after substitution in the formula.

The mean of part b was approximately 62%, which indicates that, in general, students were able to analyze data on the grizzly bear population and range size to make appropriate conclusions about the survival ability of male grizzly bears in Banff National Park. This required that students choose and analyze the appropriate data from the context in order to reach a conclusion. Students did well on this difficult question: most students at least attempted an analysis of the data. Students who had difficulty with this question chose data that would not accurately allow them to reach a conclusion or they were unable to mathematically analyze the data to reach an appropriate conclusion.

The mean of part c was approximately 55%, which indicates that many students had difficulty explaining how two factors contribute to the low biotic potential of grizzly bears. Many students did not have a good understanding of the term "biotic potential" and therefore did not explain how two selected factors contribute to a relatively low biotic potential for grizzly bears. A common error was that students listed factors that would be used to classify grizzly bears as K-selected instead of explaining how they contributed to a low biotic potential. Most students could correctly classify the grizzly bear as a K-selected species.

The mean of part d was approximately 62%, which indicates that, in general, students were able to predict the effect of the Trans-Canada Highway on genetic diversity of the grizzly bear population. Students had difficulty clearly explaining how genetic diversity would be affected and how change results from a loss or gain of unique alleles in the entire population. Some students confused change in genetic diversity with change in population numbers or gave explanations that were not clearly linked to change in alleles variability in the entire population.

The mean on part e was approximately 74%, which indicates that students were able to correctly describe a technology that could have been used in the study to determine range and migration routes of the grizzly bears.

The mean on part f was 53%, which indicates that students had some difficulty in reading and interpreting the data in the graph provided. Students who had difficulty on f.i. did not use the graph to answer the question, did not use the appropriate population size for the grizzlies in Banff National Park, or were unable to read the graph correctly. Students that had difficulty on f.ii. did not recognize the relationship in the graph as an inverse one. They were, therefore, unable to describe factors such as overcrowding and stress that might lead to a decreased reproductive rate as population size increases.

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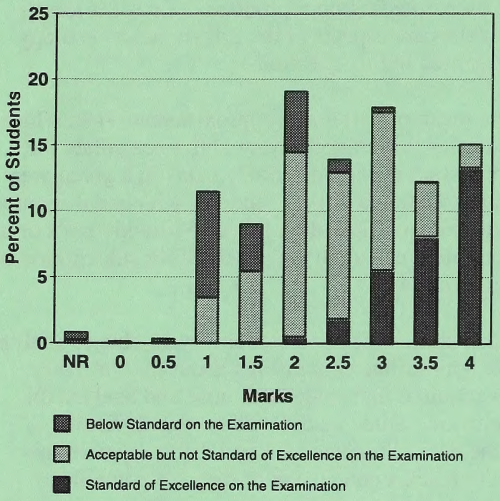
On this 12-mark question, the average mark was 7.2, or 59.7%. The acceptable standard on this question was achieved by 70.6% of the student population, and 26.3% achieved the standard of excellence with scores of 10, 11, or 12 marks (≥ 83%). Of the female students who wrote the examination, 68.4% achieved the acceptable standard and 25.4% achieved the standard of excellence. The average mark on this question for the female population was 58.5%. Of the male students who wrote the examination, 74.1% achieved the acceptable standard and 27.7% achieved the standard of excellence. The average mark on this question for the male population was 61.6%.

Distribution of Marks for Question 2



Question 2 Approximately 99% of the students who wrote this examination received some marks on this essay question. The question required students to identify possible causes of infertility in men or women and explain how these reduce the chance of pregnancy; evaluate ethical or societal issues related to reproductive technologies; and define trisomy, explain how it occurs, and describe a technology that could be used to determine the health of a fetus.

Students identified causes of infertility and explained how they affected reproductive capability very well. In general, students were able to identify issues related to infertility treatment and to evaluate them; however, some students had difficulty clearly indicating whether they were identifying an issue or giving a pro or a con in their evaluation of an issue. Students had the most difficulty defining trisomy and clearly explaining how it occurs. Many students seemed to confuse trisomy with X-linked inheritance. When explaining how trisomy occurs, they had difficulty using terminology correctly, interchanging the words gene, allele, and chromosome. Most students were readily able to identify a technological procedure that could be used to determine the genetic health of the fetus and partially describe it; however, many did not fully describe the procedure or made errors in their descriptions. In general, students addressed all parts of this question; presented unified, well-written, organized essays; and demonstrated the scientific background needed to answer most aspects of this question.

This question was marked holistically. Two markers read each response and each assigned a score from 0 to 4. These scores were added and then divided by 2 to obtain a raw score from 0 to 4. This raw score was then converted to a mark out of 12. On this 12-mark question, the average mark was 63.7%. The acceptable standard on this question was achieved by 78.2% of the student population, and 27.3% achieved the standard of excellence. Of the female students who wrote the examination, 82.0% achieved the acceptable standard and 29.3% achieved the standard of excellence. The average mark on this question for the female population was 65.9%. Of the male students who wrote the examination, 72.3% achieved the acceptable standard and 24.3% achieved the standard of excellence. The average mark on this question for the male population was 60.3%.

For further information, contact Elisa Rawe (erawe@edc.gov.ab.ca) or Corinne McCabe (cmccabe@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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